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GLARIDACRIS CATOSTOMI GEN. NOV., SP. NOV.: A CESTODARIAN PARASITE

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INTRODUCTION

In a preliminary paper Ward (1911) stated that he had found in fish from the Illinois River a cestodarian tapeworm which showed certain features common to the well known European genera, *Caryophyllaeus* and *Archigetes*. "It resembles the former in the absence of a caudal appendage and in the location chosen by the adult parasite, viz., the intestine of a fish, whereas, so far as known in Europe, *Archigetes* always possesses a tail and has been found only in the body cavity of tubificid worms. In general appearance and structure the American form resembles the European *Archigetes* very strongly. It has a scolex of fixed form with prominent suckers or phyllidea and also the musculature of *Archigetes*. The general arrangement of the reproductive organs, especially the two rows of testes in the central field, and the genital pores, correspond also closely to conditions in *Archigetes*." Much later the same writer (Ward and Whipple, 1918) merely stated in his key to the Cestodaria that, as regards *Archigetes*, "a form which undoubtedly belongs here has been described to me as found in native earthworms." Neither under *Archigetes* nor under *Caryophyllaeus* does he make any further mention of the above form, and concerning *Amphilina* says only: "Not yet reported from North America but present." Nor have I been able to locate any other reference to members of the Cestodaria, sensu latu, having been found on this continent up to date.

Before proceeding with the detailed account it should be mentioned as a matter of introduction that, apart from being evidently

the first member of the group to be described from America, the species to be dealt with here is of special interest in that it seems to stand intermediate in the family, Caryophyllaeidae Lühe 1910, between *Archigetes* and *Caryophyllaeus*. Excepting for the scolex, however, which is quite similar at least in outward appearance to that of *Archigetes brachyurus* Mrázek, it closely resembles the species of *Caryophyllaeus*, of which three, namely, *C. laticeps* (Pallas), *C. tuba* (Wagener) and *C. fennicus* Schneider, have been found in Europe, and one, *C. syrdarjensis* Skrjabin, in Asia (Turkestan).

MATERIAL

The material for the present study was obtained at the Douglas Lake Biological Station of the University of Michigan during the summer of 1917 while the writer was paying particular attention to the bothriocephalid cestodes of fishes. In all thirty-six specimens of *Catostomus commersonii* (Lacépède), the host species, were examined. These fell into two lots as regards size: ten younger ones ranging in length from 90 to 115mm. and twenty-six adults from 250 to 325mm. The latter were caught in the trammel and fyke nets used in the lake proper, while the former were seined out of Maple River which drains the lake. No parasites belonging to the species described here were met with in the younger hosts, but from two to at least sixty-three were found in the stomachs and intestines of eleven of the adults. The table shown on page 7 gives their number, distribution and kind in nine of the hosts, the exact numbers not having been recorded for the other two fish.

From this it is seen that the degree of infestation of the host is comparatively small. Whereas the number of adults met with was quite limited, larvae were very plentiful when present at all. In situ all of the adults and most of the larvae were found free in the stomach or intestine, but many larvae—forty-one in the case of the third fish in the table—were attached to the bottoms of deep pits in the mucosa of the pyloric region of the stomach. These pits were not mere depressions of the wall of the stomach but actual cavities, as shown in figure 7, bordered by a pronounced annular thickening of the mucous membrane and as much as 2mm. in diameter. Larvae ranging in size from almost the smallest met with to those near the adult stage in development were tightly crowded into these pits and at the same time strongly contracted longitudinally.

Length of host	Stomach		Intestine	
	Number	Kind	Number	Kind
285 mm	9	Adults	.....	.....
250 mm	4	Adults	.....	.....
	14	Larvae	.....	.....
275 mm	63	Larvae	.....	.....
313 mm	.....	.....	2	Larvae
282 mm	9	Larvae	52	Larvae
295 mm	.....	.....	2	Adult
			1	Larva
295 mm	7	Larvae	21	Larvae
280 mm	.....	.....	20+	Larvae
265 mm	.....	.....	12+	Larvae

EXTERNAL FEATURES

On account of its possessing a well developed musculature for its size this species exhibits considerable differences in degree of contraction and elongation on fixation. If no care is taken in applying the fixing reagent nor in slightly manipulating the specimen, it usually contracts to such an extent that it becomes almost useless, at least for the making of toto preparations. However, the adults, which are here considered to be those whose uteri may be seen in toto preparations to contain a few or many eggs, may be said to range in length from about 5 to 25mm. and from 0.4 to 1.0mm. in maximum breadth.

In immature individuals the scolex, when not strongly contracted, has somewhat the form of a truncated rectangular pyramid with the longer diameter in the transverse direction. As shown in figures 1 and 2, the edges of the base and the apex protrude markedly, in the latter case forming a terminal disc comparable to that of many of the bothriocephalid cestodes. The dorsal and ventral faces of the organ are each divided by two ridges converging towards the apex into three sucking grooves or loculi, of which the middle is best developed and most efficacious during life. It is also the last to become smoothed out with strong contraction of the whole scolex. The lateral loculi are, furthermore, not in the same plane with the medial one but inclined towards the corresponding ones of the opposite surface so that the edges of the scolex, especially just behind the

terminal disc, are often not much thicker than the ridges between the loculi. As regards these features the organ consequently resembles that of *Archigetes brachyurus* Mrázek 1908, which is here reproduced (Fig. 5) for the sake of comparison. In adults, on the other hand, the edges of the terminal disc are usually found in preserved material to be contracted to the point of obliteration, so that the whole organ is shaped more like a wedge or chisel with oftentimes rather thick margins (Figs. 3, 4 and 9). As a matter of fact the scolex of this form assumes a greater variety of shapes than that of any other tapeworm I have yet examined, in which respect it is comparable to the leaf-like anterior end of *Caryophyllaeus*. The dimensions of the organ are as follows: Length, 0.30 to 0.45mm.; width (posteriorly), 0.45 to 1.10mm.; depth (posteriorly), 0.50 to 0.75mm.

Behind the scolex the strobila narrows down for a short distance and then much more gradually enlarges again to the region of maximum diameter, which is usually behind the genital openings. Yet in many specimens, especially the more relaxed ones, the whole strobila is all but uniform in width thruout its length. The region between the scolex and formost vitelline follicles, which includes the narrowest portion of the strobila and is consequently called the neck, varies from 1.5 to 2.5mm. in length. Finally the posterior end, as shown in figure 6, is somewhat triangular in outline with a slightly indented tip where the excretory vessels open to the exterior, but bears nothing in the nature of an appendix such as it present in *Archigetes*.

CUTICULA, SUBCUTICULA AND PARENCHYMA

The cuticula, which varies in thickness from 7 to 11μ, is bounded on the inside by a comparatively heavy basement membrane, about one-sixth of the thickness of the whole layer, and on the outside by a smooth membrane about one-half as thick as the basement membrane. The remainder of the tissue has the appearance of a reticulum enclosing numerous distinct granules. This reticulum is in reality a meshwork of fine canaliculi which freely pierce both limiting membranes, thus giving them the appearance in tangential sections of fine sieves. Nowhere is the cuticula modified to form spinelets nor distinct cirri, altho over the scolex it is considerably folded and

irregular, the outer membrane being all but absent, especially within the suckers. For *Caryophyllaeus laticeps* Will (1893) described a cuticula 5 to 6μ in thickness and composed of only two layers, an outer showing radial striping, as if formed by fine bristle-like hairs, and an inner, more deeply staining stratum, comparable to the basement membrane of this form. He saw no distinct pores in the cuticula, and thought that perhaps the striations might represent prolongations of the subcuticula.

The subcuticula is made up of large flask-shaped cells, closely crowded together and provided with comparatively large nuclei. Whereas the individual cells are not distinctly separated from one another, the whole layer, from 90 to 100μ in thickness, is clearly marked off from the underlying parenchyma owing to the very granular nature of its components. The nuclei, which are spherical to oval in shape and provided with distinct spherical nucleoli, vary from 16 to 18μ in greatest diameter. They are located at different levels, so that the whole layer has a pseudostratified appearance. The enlarged central ends of the cells are usually rounded off towards the parenchyma, which feature is clearly indicated by their characteristically large granules. On the whole the subcuticula is not very different from that of *C. laticeps* as described by Will.

The parenchymatous cells form an open reticulum showing only a very few nuclei. They are in strong contrast with the subcuticular cells on account of their clear, non-granular cytoplasm. Posteriorly the whole tissue is much limited in amount by the large reproductive organs which are imbedded in it. No such "fibrous strands" of modified parenchymatous cells, as described by Will for *C. laticeps* and by Skrjabin for *C. syrdarjensis*, were seen in this form. In the base of the scolex and in the neck region, however, the medulla is occupied by a more or less X-shaped mass of cells (Fig. 10) containing large nuclei with numerous large granules which have a great affinity for the counterstain. They are probably glandular in their nature since they send long processes, especially in the diagonal direction, to the cuticula covering the scolex, between the cells of the subcuticular layer. Furthermore, no evidence of the presence of calcareous bodies in the parenchyma was met with in an examination of both fresh and preserved material.

MUSCULATURE

The musculature is comparable to that of the cestodes proper in that it is composed of two sets of fibres, the parenchymatous and the cuticular. The former consists of sagittal (dorsoventral), frontal (transverse) and two sets of longitudinal fibres, of which the latter are much the strongest. Whereas both sagittal and frontal fibres are few in number, they are not equally so, for the sagittal are somewhat larger and more numerous. Both kinds tend to course slightly obliquely where they are greatly interfered with by the reproductive organs. The main or inner longitudinal fibres are, on the other hand, comparatively large and arranged in thick bundles (Figs. 11, 12 and 13). They are situated among the central ends of the subcuticular or just within them, the cortical parenchyma being thus considerably restricted in amount. Posteriorly the fasciculi are very unequal in size and quite numerous. As they are followed forward, however, their numbers diminish while their size increases, until at the base of the scolex there are only eight large bundles arranged as in figure 10. This is brought about by the fusion of the smaller bundles and the passage of the fibres from one fasciculus to another. In longitudinal sections the bundles are irregularly striated owing to there being a considerable amount of myoplasm in the middle of each fibre around the remains of the original myoblastic nucleus. Nevertheless, no distinct nuclei such as described and figured by Will for *C. laticeps* were seen. In the posterior end of the worm many of these longitudinal muscles terminate in the walls of the excretory invagination or run alongside of it to the extremity of the strobila. The outer longitudinal group (Fig. 10) consists of a large number of bundles, smaller but more uniform in size than those of the inner group, situated among the peripheral ends of the subcuticular cells just outside of their nuclei or from 15 to 30μ from the cuticula. Posteriorly only a few of them pass beyond the anterior end of the excretory invagination, but anteriorly they are very pronounced and continue into the scolex. Similar fibres in *C. laticeps* were considered by Will to belong to the cuticular instead of to the parenchymatous series.

The cuticular muscles consists of an outer stratum of circular fibres lying close to the inside of the cuticula and an inner of longitudinal fibres situated close within that. The longitudinal fibres, which in some places intermingle slightly with some of the outermost

members of the outer longitudinal parenchymatous group, are arranged in small bundles, each containing at most only about ten or a dozen fibres. In the posterior end of the worm they proceed farther back than the latter, after being closely associated with them opposite the excretory invagination. The same may be said of the circular cuticular muscles, excepting that they are not distinctly arranged in bundles.

In the scolex the cuticular muscles are much less pronounced over the sucking-grooves than on the lateral faces. As shown in figure 9, the eight large bundles of inner longitudinal muscles, mentioned above, are arranged so that four form two sagittal pairs situated towards the lateral faces, while the other four, somewhat larger ones form two other sagittal pairs, each about half way between the nerve trunk and the median line. These are distributed in a radiating manner to the corresponding portions of the tip of the scolex, the median pairs going to the ridges between the loculi and the neighboring parts of the latter. On the whole their attachment is similar to that of the main longitudinal group in *C. tuba* and *C. laticeps*, as described respectively by Monticelli (1892) and Will. The outer longitudinal muscles are more numerous on the lateral surfaces of the scolex than opposite the suckers, to the cuticula of which they are easily traced. The loculi are also provided with a few scattered radiating fibres, lying in both the longitudinal and the transverse directions, and comparable to those used in the Pseudophyllidea for the enlargement of the bothria. They are, however, of much less functional importance in that connection than the sagittal and transverse fibres, which are somewhat larger and more numerous than in the middle of the worm. In fine, the musculature of the scolex is poorly developed as compared with that of *Bothriocephalus*, s. str., for example, which fact is shown in the great diversity of shapes of the organ in preserved material. In fact it might be considered to represent an intermediate stage between that of the anterior end of *Caryophyllaeus* and that of the typical bothriocephalid scolex. But the comparative inefficiency of the individual sucking-grooves is compensated for by their number and by their manner of attachment to the host's alimentary tract, namely at the bottom of the spacious pits described above.

NERVOUS SYSTEM

The nervous system consists of a pair of ill-defined longitudinal trunks and two equally indistinct and diffuse terminal ganglia situated in the scolex, into which they pass. The main strands can be followed more or less easily in material not especially treated to demonstrate them only in the neck region. There, as shown in figure 10, they are situated symmetrically in the median frontal plane within the trapezium formed by the two pairs of main longitudinal muscle bundles, much closer, however, to the lateral pair than to the more median pair. They supply these muscles with large branches. Whereas in the neck they are fairly uniform in diameter—which varies from 18 to 30μ—behind the most anterior vitelline follicles they become quite irregular in transection, all but disappearing in places. In the middle of the worm and posteriorly they seem to break up into a diffuse plexus lying just within the subcuticular cells, that is, among the numerous bundles of the inner longitudinal muscles. No collateral strands such as the eight described by Will for *C. laticeps* were seen in this form.

In the base of the scolex these chief nerve strands expand considerably in the dorsoventral direction and become united by a few transverse fibrils. Farther towards the tip, however, each of these enlargements divides into two parts sagittally, and each of the latter unites with its fellow of the opposite side by a loose strand of transverse fibrils, so that two anteriorly directed loops are thus formed. On the whole the nervous system is comparatively poorly developed, since not only the chief strands but also their connections in the scolex are composed of very fine, indistinct and loosely arranged fibrils.

EXCRETORY SYSTEM

Thruout most of the length of the worm the excretory system consists of a single layer of comparatively large and much coiled longitudinal vessels situated just outside of the inner longitudinal muscles among the central ends of the subcuticular cells. Whereas the number of these vessels cannot be stated definitely, owing to many transverse connecting channels, there is a tendency, especially in the anterior regions, for eight of them to take the courses indicated in figure 11. Three are located on each surface and one in the median frontal plane at each side. In the anterior part of the neck region

the number increases, and the courses of these vessels become irregular, that is, the plexus becomes more diffuse. There they invade all parts of the subcuticula and the periphery of the cortical parenchyma (Fig. 10). From 1 to 1.5mm. behind the tip of the scolex two branches leave the plexus above and below the nerve cord on each side (Fig. 10) and unite on the medial side of the latter to form one vessel. In these positions the two vessels thus formed pursue spiral courses forward and apparently unite close behind the nerve commisures mentioned above. For *C. laticeps* Fraipont (1880) and Will described an excretory system consisting in brief of four "ascending canals" and ten "descending canals," connected in the mobile anterior end of the worm with each other and posteriorly with the so-called excretory vesicle. Thus it is seen that as regards the main channels of the excretory system at least this species is somewhat less complicated in structure than the European species in question. In the posterior end of the former the plexus just described converges towards the centre of the medulla, as the vessels diminish in size, and unites by several openings with the terminal receptacle. The latter, as pointed out for *C. laticeps* by Steudener (1877), is merely an invagination of the hinder end of the worm, about 0.25mm. in length by about 0.05 in diameter. Its wall is composed of only a lining of cuticula continuous with that covering the posterior end of the worm and also traceable for some distance into the larger branches leading from the plexus into the invagination. In the sections made it was also seen to be quite vacuolated and granular and poorly provided with cuticular muscles, thus indicating that the whole structure is not a true pulsating vesicle.

Nowhere in any of the sections studied was I able to find the typical terminal organs of the excretory system, namely, the flame-cells, which according to Fraipont are present in *C. laticeps* with the same structure as those in trematodes. But in their place there appeared much less specialized cells which are, nevertheless, comparable in some respects to the ciliated funnels of other cestodes. As shown in figure 8, each consists of a large cell provided with a large nucleus with a distinct spherical nucleolus but much vacuolated cytoplasm. The cytoplasm is aggregated close around the nucleus, and from this mass numerous strands pass to the wall of the cell. The latter is directly continuous with one or more canaliculi which lead off from the structure and connect up with the larger vessels

to form the plexus. The whole has the appearance of an enlargement of the terminal vessel, enclosing an amoeboid cell which is suspended in the centre of the vesicle by its pseudopodia. Thus the vacuolated space which surrounds the cytoplasmic mass and is continuous with the cavity of the canaliculi is comparable in part at least to the funnel which accommodates the "flame" in the typical flame-cell. These terminal organs are situated close around the canals in the periphery of the cortex or even farther out among the inner ends of the subcuticular cells. Furthermore, they are much more numerous in the neck region than elsewhere. The only reference I have been able to find to structures at all comparable to these peculiar cells is that by Wright and Macallum (1887) on *Sphyranura osleri*. For this form, a monogenetic trematode, they described as the terminal renal organs peculiar elongated, club-shaped cells which are situated in close proximity to the vitelline follicles and the principal groups of muscles. The cytoplasm of the cell is divided into a number of coarse, granular trabeculae radiating from the nucleus to the wall, thus leaving a system of communicating spaces, "empty in the fixed, but often unobserved in the fresh, condition. . . . Each cell has a process at one pole, with an axial wavy channel connected with one of the neighbouring excretory capillaries . . . , the wall of which passes insensibly into the membrane of the cell." Perhaps also certain large amoeboid cells with nuclei filling up almost the whole of the cell and large nucleoli surrounded by clear areas, found by Will in specimens of *C. laticeps* fixed in Flemming's solution and crude acetic acid and described under the nervous system, may rightly belong to this category of peculiar excretory cells.

REPRODUCTIVE ORGANS

On the whole the reproductive organs of this species (Fig. 6) closely resemble those of the species of *Caryophyllaeus*. In the longitudinal direction they extend from 1.5 to 2.5mm. behind the scolex, where the foremost vitelline follicles are situated, to the posterior end of the worm. The openings and the central connections of the ducts are located, however, near the posterior end, the former, in fact, only from 1.5 to 2.8mm. from the tip, depending on the degree of contraction of the specimen. Excepting Skrjabin, the European writers emphasize in their descriptions of the species of *Caryophyllaeus* the fraction of the whole length of the worm occupied by the

organs behind the opening of the cirrus. For *C. tuba* the latter opens at the beginning of the last quarter of the body, for *C. laticeps* at the beginning of the last fifth, and for *C. fennicus* in the last fifth. Skrjabin says only that in *C. syrdarjensis* the ovary is situated in the posterior third of the body. Owing to very considerable differences in degree of contraction and elongation it seems to me that, at least so far as the present species is concerned, these proportions are not of specific value. On account of the greater development of the musculature anteriorly that portion of the body ahead of the genital openings is much more variable in length than that behind the apertures—hence the above measurements for the latter only.

The genital openings are situated in the midline on the ventral surface from 0.5 to 1.0mm. apart. The cirrus-opening is somewhat transversely elongated and about 0.15mm. in diameter. The opening of the female atrium has the form of a shallow, transverse, crescentic groove, about 0.35mm. in width, with its concave side directed anteriorly. Both apertures are so close together in most of the specimens at hand that they are located at the bottom of a common depression; or, the slight depression accommodating the male opening runs insensibly into the crescentic female atrium.

Male genitalia.—The testes (Fig. 11) are not entirely surrounded by the vitelline follicles as in *C. laticeps* and *C. syrdarjensis*. Anteriorly they begin at the same level as do the latter, and posteriorly they extend to the cirrus-sac or in some cases slightly beyond its anterior border. They are irregularly ellipsoidal in shape, and have lengths, widths and depths of from 0.135 to 0.227, 0.100 to 0.145 and 0.127 to 0.181mm., respectively. Their number as determined by direct count and by calculation from the average number in longitudinal and transverse sections varies from 150 to 160. They are especially noteworthy on account of their showing the various stages of spermatogenesis with almost diagrammatic clearness, a fact which was also noted by Monticelli in the case of *C. tuba* and by Skrjabin in his description of *C. syrdarjensis*. Nevertheless in none of the series of sections cut were any spermatozoa seen in any part of the vas deferens, altho the uteri were in the same preparations well filled with eggs. This would seem to indicate that contrary to the usual procedure among cestodes the female genital organs develop before the male organs and that self-fertilization does not take place.

The vas deferens forms a loose and somewhat triangular mass of coils about 0.32, 0.28 and 0.36mm. in length, width and depth, respectively and situated immediately ahead of the cirrus-sac. Just before entering the latter it expands into a muscular vesicula seminalis having a diameter of from 65 to 90μ and a length of about 0.30mm.; but at its beginning it has no seminal reservoir like that attributed to *C. laticeps* by Will. The wall of the duct consists of a lacerated or pseudociliated, syncitial epithelium, provided with widely separated nuclei—excepting in the seminal vesicle where they are fairly numerous—and resting on a basement membrane. The musculature of the vesicle consists of numerous circular fibres with a few oblique fibres distributed among them.

Entering the cirrus-sac anterodorsally with a diameter of 30μ, the vas deferens expands in the dorsal third of the latter to form a sort of secondary, but doubtless only temporary, seminal vesicle averaging 60μ in diameter. After taking several turns it gradually diminishes to about 35μ in the mid-region of the sac and passes insensibly into the cirrus proper. The structure of the wall of the duct within the sac up to this point is the same as that of the seminal vesicle just outside of the sac. The cirrus, which occupies the lower half of the cirrus-pouch, is a comparatively large closely coiled tube with a diameter of 60 to 65μ. Its wall, which is much cleft and folded on account of the length of the organ, is similar in structure to that of the vas deferens, excepting that the number of circular muscular fibres is much greater and that the imperfect epithelium of the latter is replaced (in the transitional region) by smooth cuticula, continuous with that of the ventral surface of the worm as in the cestodes proper. Altho in the material at hand there were no cases of extruded cirrus, its structure and disposition within the sac is such as to lead one to believe that when it is evaginated it is a comparatively long and stout organ.

The cirrus-sac (Fig. 12) is ellipsoidal in shape and occupies the whole of the medulla of the region dorsoventrally and almost all of it laterally. Its length, width and depth are, respectively, 0.40 to 0.50, 0.50 and 0.50 to 0.60mm. Its wall is composed of muscular fibres running in all directions and not sharply separated from the retractor muscles within the organ. A few dorsoventral fibres pass from the top of the sac to the dorsal body-wall and a few from

the equatorial region to the ventral body-wall. The contents of the sac are composed of numerous and very compactly arranged retractor muscles, their myoblastic nuclei and a small amount of parenchymatous tissues.

Female genitalia.—Into the dorsal portion of the female genital atrium, which is about 0.25mm. in depth and lined with a much lacerated continuation of the cuticula from the ventral surface of the worm, the vagina empties slightly to one side of the median line, the other side accomodating the opening of the uterus. From the atrium it passes backward in the median line (Fig. 6) beneath, or at some levels almost surrounded by, the coils of the uterus. Its diameter near the opening varies from 50 to 55μ, but half way along its course this is reduced to 30μ. Thruout its length its wall is composed of a lining of cuticula 5μ in thickness and surrounded by numerous circular muscles only, the myoblastic nuclei of which form a rather distinct stratum about 10μ distant from the fibres. At the level of the posterior end of the ovary it opens into the oviduct with a diameter of 8μ and a much reduced cuticular lining and layer of circular muscles. Unlike that of *C. laticeps*, as described by Will, it is nowhere enlarged to form a receptaculum seminis.

The ovary is situated usually half way between the genital openings and the posterior end of the animal (Fig. 6). It is from 0.8 to 0.9mm. in length and consists of a stout almost spherical isthmus, about 0.4mm. in diameter, from which numerous, irregular and thick lobules pass upward and slightly forward to enclose a capacious generative space. In the latter respect this form resembles not only the species of *Caryophyllaeus* but also *Cyathocephalus* and *Bothrimonus* as described elsewhere by the writer (Cooper, 1919). As shown in figure 13, the lobules lie in the periphery of the medulla, close to the main longitudinal muscles. Ova near the beginning of the oviduct average 15μ in diameter in sections, and are composed almost entirely of the nucleus, there being very little cytoplasm. A distinct and almost spherical nucleolus taking the counterstain very readily is to be seen in each nucleus.

The oviduct begins at the posterior end of the isthmus and somewhat ventrolaterally in an oocapt, 25μ in diameter by 20μ in length and provided with only a few circular muscles. About 125μ from the oocapt it is joined by the vagina. This first portion

of the oviduct is 25 to 30μ in diameter, and takes a dorsal course. Its walls are composed of a thin but uniform layer of circular muscular fibres on the outside, and on the inside of a comparatively thick layer of epithelium, the cells of which are not clearly separated from each other but contain relatively large and deeply staining nuclei. After passing backward and upward about 40μ beyond the point of union with the vagina the oviduct receives the common vitelline duct.

As in the species of *Caryophyllaeus* the vitelline follicles are located in the medulla in two distinct and separate regions: a large one extending from 1.5 to 2.5mm. behind the tip of the scolex to the cirrus sac, and a much smaller one in the more or less conical posterior end of the worm behind the coils of the uterus (Fig. 6). In the former situation they form an irregular layer in the periphery of the medulla (Fig. 11), for not only do some dip down among the testes, as mentioned above, but others extend outward to the main longitudinal muscles; in the latter, however, they occupy almost the whole of the medulla, as in *C. laticeps*. In the immature worm there is, furthermore, some tendency for them to be arranged in two lateral fields anteriorly, leaving a free strip in the median line dorsally and ventrally. In the anterior region in particular they are very numerous, irregularly ellipsoidal in shape, and vary greatly in size. From 8 to 14 appear in transections, while their maximum diameter is 0.20mm. Posteriorly they are slightly larger.

The process of the formation of the peculiarly clear yolk-cells which are to be seen in the vitelline ducts (Fig. 14c) can be followed with a considerable degree of satisfaction in the follicles. The cytoplasm of the small peripheral primordial cells from which they develop is very compact, and consequently stains deeply as does the nucleus (Fig. 14a). Numerous vacuoles appear in it and quickly enlarge, so that in the intermediate stages the nucleus appears to be suspended in the centre of the cells by protoplasmic strands radiating from it to the cell-membrane, as shown in figure 14b. These strands become modified into numerous, spherical deutoplasmic granules, migrate outward and eventually come to lie just inside the cell-membrane (Fig. 14c). In the proximal part of the uterus, where from four to six vitelline cells are seen to be associated with each fertilized ovum in the formation of the egg, the nucleus enlarges still

more and becomes more transparent, while the cell-wall gradually breaks down, thus liberating the vitelline granules. The enlarged nuclei remain intact, however, during the passage of the egg thru almost the whole length of the uterus.

The common vitelline duct varies in diameter from 30 to 75μ, and is lined by an epithelium similar to that of the oviduct. It is largest immediately dorsal to the posterior end of the ovarian isthmus where it forms a vitelline reservoir, as in *C. laticeps*, as much as 220μ in width by 45μ in depth when filled with yolk. A little farther forward it receives two main tributaries, varying considerably in calibre according to the amount of vitelline material they contain. Whereas these two ducts collect chiefly from the follicles ahead of the uterus, at least one small tributary on each side drains the follicles situated in the posterior end of the worm, and unites with the main ducts near their point of union with each other.

Shortly after being joined by the common vitelline duct and as it courses a little farther back on one side or the other, the oviduct becomes surrounded by a poorly developed shell-gland. The ootype is consequently inconspicuous. Beyond the ootype the epithelium is syncitial in its nature since no distict cell-boundaries appear. More than its inner half is deeply cleft to form pseudocilia, yet its nuclei are comparatively large. As the oviduct—now, more properly called the beginning of the uterus—continues backward in a dorsal position in the medulla, it gradually enlarges, according as it becomes filled with eggs, its wall becomes thinner and thinner, and the nuclei diminish in number, flatten out and eventually disappear. The latter takes place particularly after the organ turns in its course—just ahead of the posterior group of vitelline follicles—and starts forward towards the female genital atrium.

From a point just behind the level of the posterior border of the ovarian isthmus to its opening the uterus is surrounded by a voluminous mass of club-shaped, unicellular glands (Fig. 13), similar to those described for the species of *Caryophyllaeus* and closely resembling those described by the writer (1919) for *Cyathocephalus americanus* and *Bothrimonus intermedius*. As to the function of these cells no definite statements can be made as yet. Monticelli likened the similar cells in *C. tuba* to those to be seen along the uteri of many trematodes as well as of *Gyrocotyle urna* (Wagener), and called them

glutin-producing glands. Will described them in *C. laticeps*, and said that they were "fully identical" with those in *Diphyllobothrium latum*. He also incidentally mentioned that Saint-Remy (1890) looked upon them as a shell-gland. Schneider (1902) called them glandular cells in *C. fennicus*, while Skrjabin considered them to be shell-glands in *C. syrdarjensis*. In view of the fact that, as in the species of the subfamily Cyathocephalinae just mentioned, the shell-gland surrounding the ootype is poorly developed—altho it was clearly seen in this species to initiate the formation of the egg-shell—they may act as an accessory shell-gland. Even tho this whole region of the uterus is lined with a deeply cleft cuticula, numerous droplets of material were seen in the sections studied adhering to or lying among the pseudocilia as if they were secreted from the cells in question; and it is only in this portion of the uterus, not in the thin-walled proximal region, that the shells of the eggs are thickest. At any rate, since the uterus is provided with only a very few scattered circular muscles, excepting just before its opening, they cannot be myoblastic in their nature. Distally they diminish considerably in number, yet they are directly continuous with the myoblastic nuclei of the more numerous muscular fibres surrounding the terminal portion of the duct and the female atrium, which in turn are continuous with the subcuticular cells around the atrial opening. As stated above, the uterus opens into the female genital atrium ahead of and slightly to one side of the vagina. The atrium itself is from 0.20 to 0.30mm. in length by about 0.10mm. in diameter and lined with a very irregular and deeply cleft cuticula.

The mature fresh eggs, when examined in normal saline solution, were found to be ovoid in shape and from 54 to 66μ in length by 38 to 48μ in width. The shell is from 2 to 3μ in thickness, and is provided at its larger end with a small button-like boss and at its smaller end with an operculum from 12 to 16μ in diameter.

LIFE HISTORY

As regards the development and life-history of this species only a few statements can be made at present. Larvae as small as that shown in figure 15 were found in the stomach of the host, but, altho a thoro dissection of the food-contents, which consisted of larvae of *Chironomus* and *Simulium*, Ostracoda, Cladocera, "caddice-worms,"

dragon-fly nymphs and Mollusca, was made, their mode of entrance was not discovered. Possibly further search will show that some member of these groups of animals, if not a tubificid worm as in Europe, is the intermediate host. Finally, from the standpoint of the systematic position of the species it should be emphasized that the smallest larvae found had nothing whatsoever in the nature of appendages.

SYSTEMATIC POSITION

From the above description it is clear that this species, altho a member of the family Caryophyllaeidae Lühe 1910, does not belong either to *Archigetes* or to *Caryophyllaeus*. As pointed out above, the scolex resembles that of at least one species of *Archigetes*, namely, *A. brachyurus* Mràzek, but is quite different from the simple, leaf-like anterior ends of the species of *Caryophyllaeus*. The reproductive organs, it is true, are much more comparable to those of the latter, but certain features of the muscular, excretory and nervous systems do not permit of its being placed in either genus. Consequently a new genus is erected to accommodate this form, and is given the following characters:

Glaridacris gen. nov.

With the characters of the family. Medium sized caryophyllaeids with the anterior end modified to form a scolex, provided on each surface with three suckers, of which the median one is the deepest and most efficacious. Main longitudinal parenchymatous muscles in eight large fasciculi in the anterior part of the neck and the base of the scolex. Only two main nerve strands in the medulla, connected in the scolex by two more or less diffuse commissural loops. Excretory vessels form a single cortical plexus with eight principal longitudinal channels; no true flame-cells present, terminal renal organs, peculiar, highly vacuolated, simple cells. Expansion of the vas deferens before entering the cirrus-sac to form a vesicula seminalis. δλαρίς, chisel; ἄκρις, summit.

Type, and as yet only, species: *G. catostomi* sp. nov.

The principal specific characters may be set down as follows:

Glaridacris catostomi sp. nov.

With the characters of the genus. Small cestodarians, up to 25mm. in length by 1.0mm. in breadth. Scolex, short and broad, chisel-shaped in older specimens, hexagonally pyramidal with prominent terminal disc in younger, base large in both; length, 0.30 to 0.45mm., width (posteriorly), 0.45 to 1.10mm., depth (posteriorly), 0.50 to

0.75mm. Neck only slightly narrower than body, 1.5 to 2.5mm. in length; whole worm, apart from scolex, cylindrical, with somewhat conical posterior end.

Cuticula, 7 to 11μ in thickness; subcuticula, 90 to 100μ. No "fibrous strands" nor calcareous bodies in parenchyma.

Female genital atrium, 0.5 to 1.0mm. behind opening of cirrus, 0.20 to 0.30mm. in depth by 0.10mm. in diameter, opening crescentic, in same depression with male opening.

Testes not completely surrounded by vitelline follicles; extend to cirrus-sac posteriorly; irregularly ellipsoidal in shape, from 0.10 to 0.18mm. in different diameters; 150 to 160 in number. Vas deferens, a loose somewhat triangular mass ahead of cirrus-sac, 0.28 to 0.36mm. in diameter. Vesicula seminalis, 0.30 by 0.06 to 0.09mm. Cirrus-sac large, almost spherical, occupying almost whole of medulla of region, 0.40 to 0.60mm. in diameter. Cirrus, 60 to 65μ in diameter.

Vagina median, ventral, 30 to 55μ in diameter. Ovary irregularly lobular, 0.8 to 0.9mm. in length, with nearly spherical isthmus, 0.4mm. in diameter. Oocapt, 20 by 25μ. Vitelline follicles not completely surrounding the testes, 8 to 14 in transections, 0.20mm. in maximum diameter. Vitelline reservoir, the expanded common vitelline duct, 220 by 45μ. Ootype inconspicuous. Uterus in two portions, a proximal, thin-walled, and a distal, extending from the posterior vitelline follicles to the opening and surrounded by a large number of unicellular glands; empties into female atrium slightly ahead of and to one side of vagina.

Eggs, ovoid, with small boss at larger end, 54 to 66μ in length by 38 to 48μ in width.

Habitat: In stomach and intestine of *Catostomus commersonii* (Lacépède).

Finally, Lühe's (1910) characterization of the family will have to be slightly emended to include this new species:

CARYOPHYLLAEIDAE Lühe 1910, e.p.

Monozootic pseudophyllidea with scolex unarmed; may or may not bear more or less well expressed sucking organs which are set off from the rest of the body by a neck-like constriction or are fused with the same without such. A caudal appendage bearing on its hinder end the hooks of the oncosphere may also be present in the sexually mature animal. Genital organs present only singly. Reproductive openings surficial, ventral, medial and near the posterior end. Testes, numerous, exclusively anterior to the ovary and the female genital ducts. Cirrus unarmed, ahead of the female sexual apertures; vagina and uterus open at the bottom of a common vestibule which resembles in its histological structure the shallow genital atrium and opens into it close behind the cirrus. Ovary two-winged, directly behind the genital opening. Vitelline follicles in the medulla, but peripheral to the testes and more or less completely surrounding them like a mantle; mostly ahead of the ovary, but a group also in the hinder end of the body, separated from the main mass by the ovary and the female genital ducts. Uterus a winding canal, without sack-like expansions. Eggs, operculate.

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EXPLANATIONS OF FIGURES

co cirrus opening
cs cirrus-sac
ev excretory vessel
fa female atrium
g glands
i isthmus of ovary
lm longitudinal muscles
n nerve(s)
ns nerve strand

o	ovary	*t*	testis
olm	outer longitudinal muscles	*u*	uterus
rc	renal cell	*v*	vagina
sg	shell-gland	*vf*	vitelline folliscles
		vs	vesicula seminalis

Unless otherwise stated, the lines indicating the magnifications of the figures are 0.5mm. in length.

PLATE I

Fig. 1. Surficial view of scolex of specimen 3.5mm. in length.
Fig. 2. Lateral view of same.
Fig. 3. Surficial view of scolex of specimen 21mm. in length.
Fig. 4. Lateral view of same.
Fig. 5. Scolex of *Archigetes brachyurus*, surficial view. After Mrázek.
Fig. 6. Genital organs in posterior end of worm, toto preparation, surficial view.
Fig. 7. Pits in the mucosa of the host's intestine, each showing only two of the several larvae found in them.
Fig. 8. A terminal renal cell and its connections, from a frontal section. The line at the side represents 0.05mm.

PLATE II

Fig. 9. Transection thru the middle of the scolex.
Fig. 10. Transection thru the anterior part of the neck.
Fig. 11. Transection thru about the middle of the whole worm.
Fig. 12. Transection thru the cirrus-sac.
Fig. 13. Transection thru the ovarian isthmus.
Fig. 14. Three stages in the development of the vitelline cells: *a*, the primordial cell from the periphery of the follicle; *b*, an intermediate stage from the centre of the follicle; *c*, the mature cell from the vitelline reservoir. The line repersents 0.02mm.
Fig. 15. The smallest larvae procured.

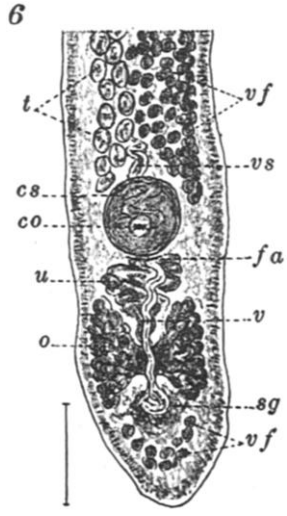
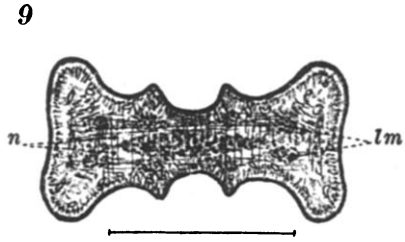
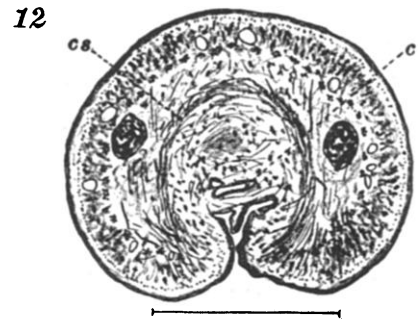
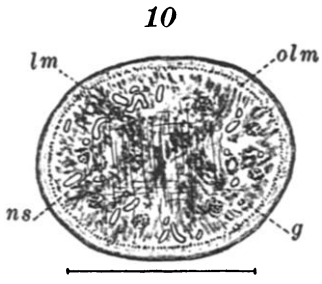


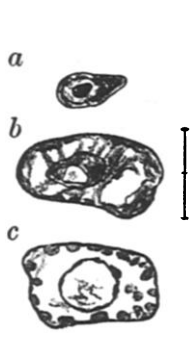
PLATE I

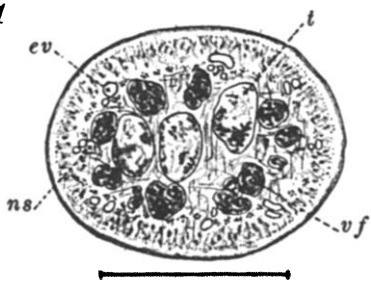
COOPER











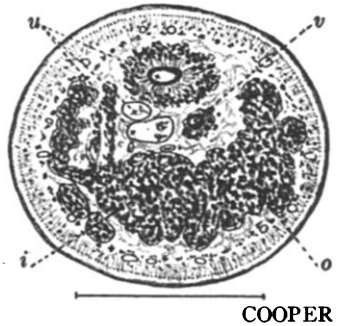


PLATE II

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